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(54) Title: USE OF SOLUBLE TUMOR NECROSIS FACTOR RECEPTOR FOR TREATMENT HEART FAILURE			
(57) Abstract  The invention provides methods of treating chronic heart failure in a human patient by repeatedly administering TNFR:Fc for a time sufficient to induce an improvement in an indicator of chronic heart failure.			

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## USE OF SOLUBLE TUMOR NECROSIS FACTOR RECEPTOR FOR TREATMENT HEART FAILURE

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### BACKGROUND OF THE INVENTION

10       Chronic heart failure (CHF), also called "congestive heart failure," occurs when the heart is damaged from diseases such as high blood pressure, a heart attack, poor blood supply to the heart, a defective heart valve, atherosclerosis, rheumatic fever, heart muscle disease and so on. The failing heart becomes inefficient, resulting in fluid retention and shortness of breath, fatigue and exercise intolerance. CHF is defined by the  
15       symptom complex of dyspnea, fatigue and depressed left ventricular systolic function (ejection fraction < 35-40%), and is the ultimate endpoint of all forms of serious heart disease.

      Treatment of CHF has been directed primarily to prolonging the patient's life, although the benefits from treatment generally is assessed through improvement in other  
20       areas. For example, a reduced degree of dyspnea or improvement in performance in a standardized walking test have a substantial positive impact on the lifestyle of patients who live with this disease. An increased ejection fraction, which can be measured by echocardiogram or by multigated radionuclide ventriculography (MUGA), is another indicator of a successful treatment regimen.

25       It has been proposed that the cytokine TNF $\alpha$  may contribute to the progression of heart failure by exerting direct toxic effects on the heart and the circulation (see, e.g., Yokoyama et al., *J. Clin Invest* 92:2303-2312, 1993; Torre-Amione et al., *Circulation* 93: 704-711, 1996. TNF $\alpha$  is a pleiotropic cytokine that is produced by the heart under certain forms of stress (Kapadia et al., *J. Clin Invest* 96:1042-1052, 1995b; Kapadia et al., *Circ*  
30       *Res* 81: 187-195, 1997). For example, patients with various types of heart disease have elevated levels of circulating TNF $\alpha$ , and the levels of TNF $\alpha$  have been shown to increase with disease progression (see, e.g., Maury et al., *J. Intern Med* 225: 333-336, 1989; Levine et al., *N Engl J Med* 323: 236-241, 1990; McMurray et al., *Br Heart J* 66: 356-358, 1991; Han et al., *JACC* 19(3): 207A Abstract #768-6, March 1, 1992; Matsumori et  
35       al., *Br Heart J* 72: 561-566 1994b; Satoh et al., *J. Am. Coll. Cardiol.* 29: 716-724, 1997; Seta et al., *J. Cardiac Failure* 2: 243-249, 1996; Torre-Amione et al., *Circulation* 93:704-711, 1996b).

5 Pathophysiologically relevant peripheral and/or elevated intramyocardial levels of TNF $\alpha$  are sufficient to mimic many aspects of the heart failure phenotype, including left ventricular dilation, left ventricular dysfunction, as well as activation of the fetal gene program (Suffredini et al., *N Engl J Med* 321:280-287, 1989; Hegewisch et al., *Lancet* 2:294-295, 1990), hence it has been suggested that TNF $\alpha$  plays a contributory role in the  
10 pathogenesis of heart failure (see, e.g., Seta et al., *J. Cardiac Failure* 2:243-249, 1996).

It has been suggested that suppression of TNF $\alpha$  might benefit CHF patients (e.g., McMurray et al., *Br Heart J* 66:356-358, 1991), and many studies have provided support for this proposal. For example, TNF $\alpha$  has been shown in isolated hamster heart to inhibit contractility (Finkel et al., *Science* 257:387-389, 1992). In mice, antibodies against TNF $\alpha$   
15 were effective in ameliorating the severity of artificially-induced heart disease (Smith et al., *Circ Res* 70: 856-863, 1992). In another study, TNF $\alpha$ -induced depression in left ventricle function in rats was partially reversed by administering the TNF $\alpha$  antagonist TNFR:Fc (Bozkurt et al., *Circulation* 97(14): 1382-1391, 1998), and in yet a different study, TNFR:Fc was shown to suppress the negative inotropic effect of TNF in cultured  
20 myocytes (Kapadia et al., *Am J Physiol* 37:H517-H525, 1995a). Others demonstrated that TNFR:Fc could reduce burn-induced myocardial dysfunction in guinea pigs (Giroir et al., *Am J Physiol* 267 (Heart Circ Physiol 36):H118-H125, 1994). Another study showed that vesnarinone, an agent used to treat CHF, could suppress lipoprotein-induced TNF $\alpha$  production human blood cells *in vitro* (Matsumori et al., *Circulation* 89:955-958, 1994a).

25 A small group of human CHF patients were given a single dose of TNFR:Fc, and fourteen days later exhibited decreased levels of circulating TNF $\alpha$ , increased ability to exercise, and improved symptomology (Deswal et al., Abstract #472, American Heart Association 70<sup>th</sup> Scientific Session, *Circulation* 96(8Suppl.), 1997 I323). In addition, the TNF $\alpha$  suppressor pentoxifylline reportedly induces improved left ventricle function  
30 concomitant with decreased levels of serum TNF $\alpha$  levels in patients with idiopathic dilated cardiomyopathy (Skudicky et al., American Heart Association Meeting, Abstract No. 3415 November, 1998; Sliwa et al., *Lancet* 351: 1091-1093, 1998). The treatment of various heart diseases with TNF $\alpha$  antagonists is disclosed also in a number of U.S. patents and in several published patent applications (see, e.g., U.S. 5,594,106; U.S.  
35 5,629,285; U.S. 5,691,382; U.S. 5,700,838; U.S. 5,886,010; WO 91/15451; WO

5 94/10990; WO 95/19957; WO 96/21447; WO 97/30088; EP 0 453 898 B1; EP 0 486 809 A2; EP 0 626 389 A1).

TNF $\alpha$  binds to cells through two membrane receptor molecules having molecular weights of approximately 55 kDa and 75 kDa (p55 and p75). In addition to binding TNF $\alpha$ , these same receptors mediate the binding to cells of TNF $\beta$ , which is another  
10 cytokine associated with inflammation. TNF $\beta$ , also known as lymphotoxin- $\alpha$  (LT $\alpha$ ), shares structural similarities with TNF $\alpha$  (Cosman, *Blood Cell Biochemistry* 7: 51-77, 1996).

Although progress has been made in devising effective treatment for CHF in human patients, improved medicaments and methods of treatment are needed.

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### SUMMARY OF THE INVENTION

The invention provides methods for treating chronic heart failure by repeatedly administering a recombinant TNFR:Fc, more specifically, etanercept, for a period of time sufficient to induce a sustained improvement in the patient's condition.

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### BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 illustrates the improved NYHA classification that was observed in the patients who received etanercept in the study described in Example 1.

FIGURES 2A and 2B illustrate the improved left ventricular ejection fraction by  
25 MUGA in the patients who received etanercept in the study described in Example 1.

FIGURE 3 illustrates the improved Quality of Life (MLWHF) that was observed in patients who received etanercept in the study described in Example 1.

FIGURE 4 illustrates the end-of-study clinical composite score distributions for the patients who participated in the study described in Example 1.

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### DETAILED DESCRIPTION OF THE INVENTION

The invention provides methods of treating chronic heart failure (CHF) that involve administering to a CHF patient a TNF $\alpha$  antagonist that is capable of inhibiting the binding of TNF $\alpha$  to a TNF $\alpha$  receptor. In a preferred embodiment of the invention, the  
35 TNF $\alpha$  antagonist is one that mimics the 75 kDa TNFR and that binds to TNF $\alpha$  in the patient's body. Once bound to the antagonist, the TNF $\alpha$  is prevented from binding its

5 natural receptor, and thus cannot manifest its biological activities. A TNF $\alpha$  antagonist suitable for use in treating CHF is recombinant TNFR:Fc (hereafter referred to as "TNFR:Fc" or "etanercept"). Etanercept is currently sold by Immunex Corporation under the trade name ENBREL,<sup>®</sup> and is a dimer of two molecules of the extracellular portion of the p75 TNF $\alpha$  receptor, each molecule consisting of a 235 amino acid polypeptide that is  
10 fused to a 232 amino acid Fc portion of human IgG<sub>1</sub>. In addition to etanercept, the use of other soluble mimics of the p75 molecule for treating CHF are within the scope of the invention.

To treat CHF, TNFR:Fc or another TNF $\alpha$ -binding mimic of p75 is administered repeatedly to a CHF patient in an amount and for a time sufficient to induce a sustained  
15 improvement over baseline in at least one indicator that reflects the degree of the patient's heart disease. For purposes of this invention, an improvement is considered "sustained" if the patient exhibits the improvement on at least two occasions separated by at least four weeks. A sustained degree of improvement generally is obtained by repeatedly administering TNFR:Fc over a period of at least a month, e.g., for one, two, or three  
20 months or longer.

Various indicators that reflect the patient's degree of heart failure may be assessed for determining whether the amount and time of the treatment is sufficient. The baseline value for the chosen indicator or indicators is established by examination of the patient within about 60 days prior to administration of the first dose of the etanercept or other  
25 TNF $\alpha$ -binding molecule.

If administered by injection, the effective amount of TNFR:Fc ranges from 1-20 mg/m<sup>2</sup>, and preferably is about 5-12 mg/m<sup>2</sup>. Alternatively, a flat dose may be administered, whose amount may range from 5-100 mg/dose. An exemplary range for a flat dose is about 20-30 mg per dose. In one embodiment of the invention, a flat dose of  
30 25 mg/dose is repeatedly administered by subcutaneous injection. If a route of administration other than injection is used, the dose is appropriately adjusted in accord with standard medical practices.

Regardless of route of administration, it should be understood that the specific dose level and frequency of administration for a given patient may depend upon a variety  
35 of factors such as their age, body weight, general health, sex, diet, time of administration,

5 other drugs being concurrently administered, side-effects the patient may experience and the severity of their heart disease.

In one of the preferred embodiments of the invention, chronic heart failure is treated by administering to the patient by subcutaneous injection a dose of TNFR:Fc at 5 mg/m<sup>2</sup> or 12 mg/m<sup>2</sup> per dose up to a maximum of 25 mg per dose at least two times per  
10 week for a time sufficient to induce a sustained improvement over baseline of one of the following indicators: i) left ventricular ejection fraction; ii) New York Heart Association class; and iii) clinical composite score.

In one embodiment of the invention, the sufficiency of treatment is determined by evaluating the patient for an improvement in their left ventricular function. A sufficient  
15 degree of improvement with respect to this indication is obtained by repeatedly administering a dose of TNFR:Fc or other TNF $\alpha$ -binding molecule until the patient manifests an at least 5%, or more preferably an at least 10% increase over baseline in left ventricular ejection fraction. The left ventricular ejection fraction can be determined by any suitable means, such as echocardiogram or by multigated radionuclide  
20 ventriculography (MUGA).

In another embodiment, the treatment is regarded as sufficient when it has induced a sustained improvement in the recipient's clinical composite score. A patient's clinical composite score is designated as "improved," "unchanged," or "worse" relative to baseline according to the following definitions. "Worse" means that the patient (1) died;  
25 (2) has had a hospitalization related to CHF; (3) has a worse NYHA functional classification (e.g., degenerates from Class I to Class II, from Class II to Class III or from Class III to Class IV); or (4) indicates that he or she feels moderately or markedly worse in a subjective patient global assessment after 24 weeks of treatment. The patient global assessment consists of the patient's response when asked whether their heart failure is:  
30 markedly better; moderately better; slightly better; unchanged; slightly worse; moderately worse; or markedly worse. An "improved" clinical composite score means that NYHA class is decreased by at least one class level (e.g., from Class III to Class II) and that the patient's global assessment of CHF is moderately or markedly improved. If the patient's clinical composite score is neither worse nor improved according to the foregoing criteria,  
35 then the clinical composite is scored as "unchanged." If clinical composite score is used as an indicator of the patient's degree of heart failure, a designation of "improved" is

5 considered indicative that the time and amount of the treatment with TNFR:Fc is sufficient.

In another embodiment of the invention, the indicator used to assess the patient's degree of heart failure is NYHA class of heart disease, and the amount and time of treatment is considered sufficient if the treatment has induced the patient's NYHA class  
10 to improve by at least one level, e.g., from Class II to Class I, from Class III to Class II, or from Class IV to Class III.

In yet another embodiment of the invention, the amount and time of treatment with TNFR:Fc is determined to be sufficient when the treatment has induced an increase in the patient's quality of life as scored by the Minnesota Living with Heart Failure  
15 Quality of Life Questionnaire (MLWHF Scale). Preferably, the treatment will induce an improvement of at least 19%, or more preferably at least 25% over baseline in the patient's MLWHF score.

Although a patient's degree of CHF after treatment may appear improved according to one or more of the above-discussed indices of heart condition, it should be  
20 understood that treatment with TNFR:Fc may be continued after the patient has shown improvement, and may be continued indefinitely if the patient's physician determines that this would be beneficial to the patient. Long-term treatment may be administered at the original dose or at a reduced maintenance dose. Moreover, if the treatment is discontinued for any reason, the treatment may be resumed if the patient's condition  
25 should worsen.

In addition to subcutaneous injection, any other efficacious route of administration may be used to therapeutically administer TNFR:Fc or other TNF $\alpha$  antagonist comprising a TNF receptor. TNFR:Fc can be administered to a CHF patient, for example, via intra-articular injection, intramuscular injection, intraperitoneal infusion or bolus injection,  
30 continuous infusion into a vein or artery, intrathecal or subdural injection, sustained release from implants, aerosol inhalation, suppository, oral preparations, such as tablets, capsules, pills or syrups, transdermal patch, biodegradable microcapsules or other suitable techniques, such as *in vivo* or *ex vivo* transfection of the patient's cells with recombinant DNA expressing a TNFR:Fc polypeptide.

35 Typically, TNFR:Fc is administered in the form of a composition comprising purified recombinant protein in conjunction with physiologically acceptable carriers.

5 excipients or diluents. Such carriers should be nontoxic to recipients at the dosages and concentrations employed. Ordinarily, the preparation of such compositions entails combining the TNFR:Fc with buffers, antioxidants such as ascorbic acid, low molecular weight polypeptides (such as those having fewer than 10 amino acids), proteins, amino acids, carbohydrates such as glucose, sucrose or dextrans, chelating agents such as EDTA, 10 glutathione and other stabilizers and excipients. Neutral buffered saline or saline mixed with conspecific serum albumin are exemplary appropriate diluents. Preferably, the TNFR:Fc is formulated as a lyophilizate using appropriate excipient solutions (e.g., sucrose) as diluents. Appropriate dosages can be determined in standard dosing trials, and may vary according to the route of administration that is chosen. In accordance with 15 appropriate industry standards, preservatives may also be added, such as benzyl alcohol. The amount and frequency of administration will depend, of course, on such factors as the nature and severity of the indication being treated, the desired response, the condition of the patient, and so forth.

The compositions described herein preferably are administered at least one time 20 per week. In a preferred embodiment of the invention, TNFR:Fc is administered at least two times per week, and in another preferred embodiment, it is administered at least three times a week.

Etanercept is a dimeric TNFR that competes for TNF $\alpha$  with the receptors on the cell surface, thus inhibiting TNF $\alpha$  from binding to the cell. In contrast to many other 25 types of TNF inhibitor, inhibitors comprising a TNFR are capable also of binding to the inflammatory cytokine LT $\alpha$ . Thus, TNFR:Fc has the capacity to suppress the binding of LT $\alpha$  to its natural receptors, which may contribute to the potency of TNFR:Fc.

The following examples are provided to illustrate the advantages of the invention, and are not intended in any way to limit the scope of the disclosure.

30

### EXAMPLES

#### Example 1. Evaluation of TNFR:Fc in patients with chronic heart failure.

Forty-seven patients with Class III-IV heart failure were evaluated in a Phase I/II randomized, placebo controlled double-blinded study to determine whether the long-term subcutaneous biweekly administration of etanercept (recombinant TNFR:Fc) was safe in 35 this patient population and whether efficacy could be documented. Two dose levels of TNFR:Fc were evaluated in this study. To assess improvement in the patient's degree of



- 5 heart disease, parameters assessed at the end of the study included ventricular function (as indicated by left ventricular ejection fraction), NYHA class, quality of life, clinical composite score, as well as numerous other measures that reflected the patient's degree of heart disease. Baseline values for all of these parameters were established prior to administration of the first dose of etanercept or placebo.
- 10 Efficacy was evaluated by assessing clinical and laboratory indices for evidence of improvement in: NYHA class; serum levels of TNF $\alpha$ ; left ventricular ejection fraction by MUGA; left ventricular volume by MUGA; left ventricular ejection fraction and dimension and cardiac output by 2-D echo; exercise tolerance by six minute walk test; quality of life (visual analog and Minnesota Living with Heart Failure); global assessment
- 15 of heart failure (VAS), including patient global assessment and physician global assessment; and heart size. At the beginning and at the end of the study (days 1 and 84), serum was collected for determination of TNF $\alpha$ , TNFR:Fc antibodies, IL-1 $\alpha$ , IL-6, IL-10, norepinephrine, plasma renin activity and atrial natriuretic factor levels. The study also tracked the degree to which the two study groups required hospitalization for any cause.
- 20 Values measured during and after the study were compared to baseline values.

The walking test is a simple objective guide to disability in patients with chronic heart failure. The tests were carried out in a level corridor and each patient was instructed prior to the test to cover as much ground as possible in 6 minutes.

- 25 Classification according to the New York Heart Association (NYHA) criteria was performed as follows:

**CLASS I**

No limitation of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, or dyspnea.

30 **CLASS II**

Slight limitation of physical activity. Comfortable at rest, but ordinary physical activity results in fatigue, palpitation, or dyspnea.

5 CLASS III

CLASS IIIA: Marked limitation of physical activity. Comfortable at rest, but less than ordinary activity causes fatigue, palpitation, or dyspnea.

CLASS IIIB: Marked limitation of physical activity. Comfortable at rest, but minimal exertion causes fatigue, palpitation or dyspnea.

10 CLASS IV

Unable to carry on any physical activity without discomfort. Symptoms of cardiac insufficiency present at rest. If any physical activity is undertaken, discomfort is increased.

The above criteria were derived from the Committee of the New York Heart Association: Nomenclature and Criteria for Diagnosis of the Heart and Great Vessels (8<sup>th</sup> Edition, Boston: Little, Brown and Co., 1979), but were modified to add Classes IIIA and IIIB.

Clinical composite was assessed for each patient at the beginning and end of the study. After the clinical composite assessment, each patient was classified as "better," "worse," or "unchanged." The clinical composite for each patient was considered to be improved, unchanged or worse at the end of the study based on the following definitions:

Worse:

1. died;
2. had a CHF hospitalization;
- 25 3. has worse NYHA functional classification at 24 weeks;
4. has indicated moderately or markedly worse on the patient global assessment at 24 weeks.

Patients were considered "worse" if events 1 and 2 above occurred within 24 weeks following randomization or if events 3 or 4 occurred at 24 weeks. A patient was considered to have had a CHF hospitalization if he/she was hospitalized for or with worsening heart failure (admission of at least 1 day defined as a change in dates) and received intravenous diuretics, vasodilators or positive inotropic drugs for the treatment of heart failure.

Improved:

- 35 NYHA class was improved; and

- 5 Overall assessment of CHF (judged by patient global assessment) was judged to be moderately or markedly improved.

Unchanged:

If at 24 weeks, the patient was neither worse nor improved, then he/she was classified as "unchanged."

- 10 The Minnesota Living with Heart Failure Quality of Life scale was assessed by presenting patients with the following questionnaire (Rector et al., 1983, 1987 and 1992):

- 15 These questions concern how your heart failure (heart condition) has prevented you from living as you wanted during the last month. The items listed below describe different ways some people are affected. If you are sure an item does not apply to you or is not related to your heart failure then circle 0 (No) and go on to the next item. If an item does apply to you, then circle the number rating how much it prevented you from living as you wanted. Remember to think about ONLY THE LAST MONTH.

20

Did your heart failure prevent you from living as you wanted during the last month by:		Very Little					Very Much
		No	1	2	3	4	5
1.	Causing swelling in your ankles, legs, etc.?	0	1	2	3	4	5
2.	Making you sit or lie down to rest during the day?	0	1	2	3	4	5
3.	Making your walking about or climbing stairs difficult?	0	1	2	3	4	5
4.	Making your working around the house or yard difficult?	0	1	2	3	4	5
5.	Making your going places away from home difficult?	0	1	2	3	4	5
6.	Making your sleeping well at night difficult?	0	1	2	3	4	5
7.	Making your relating to or doing things with your friends or family difficult?	0	1	2	3	4	5
8.	Making your working to earn a living difficult?	0	1	2	3	4	5
9.	Making your recreational pastimes, sports or hobbies difficult?	0	1	2	3	4	5
10.	Making your sexual activities difficult?	0	1	2	3	4	5
11.	Making you eat less of the foods you like?	0	1	2	3	4	5
12.	Making you short of breath?	0	1	2	3	4	5
13.	Making you tired, fatigued, or low on energy?	0	1	2	3	4	5
14.	Making you stay in a hospital?	0	1	2	3	4	5
15.	Costing you money for medical care?	0	1	2	3	4	5
16.	Giving you side effects from medications?	0	1	2	3	4	5
17.	Making you feel you are a burden to your family or friends?	0	1	2	3	4	5
18.	Making you feel a loss of self-control in your life?	0	1	2	3	4	5
19.	Making you worry?	0	1	2	3	4	5
20.	Making it difficult for you to concentrate or remember things?	0	1	2	3	4	5
21.	Making you feel depressed?	0	1	2	3	4	5

5           The numbers 0-5 assigned to each of the 21 answers were added together to obtain the patient's MLWHF score.

Patient enrollment

          Patients who were eligible for enrollment met the following criteria: male or female between 18 and 75 years of age; not pregnant if female; willing to practice  
10   contraception during the trial; NYHA Class III or IV (see below); ejection fraction  $\leq 35\%$  (as assessed by radionuclide ventriculography within 60 days prior to randomization); receiving standard and stable (1 month) triple therapy for heart failure (angiotensin converting enzyme (ACE) inhibitor and diuretics); able to walk a minimum of 100 m during a standard 6 minute corridor walking test. Patients with severe infections were  
15   excluded. All patients provided informed consent.

          Patients were permitted to continue all maintenance cardiac medications while enrolled in this study, and the dose level of etanercept for each enrolled patient remained constant throughout the study. Basic demographic information was collected from all enrolled patients, and were found to be comparable in all three treatment groups.

20   Dosing regimen

          Recombinant human TNFR:Fc (etanercept) that was used in this study was obtained from Immunex Corporation. The gene fragments encoding the etanercept polypeptides were expressed in a Chinese hamster ovary (CHO) expression vector.

          TNFR:Fc was supplied as a sterile lyophilized powder containing 10 mg or 25 mg  
25   TNFR:Fc; 40 mg mannitol, USP; 10 mg sucrose, NF; and 1.2 mg tromethamine (TRIS), USP per vial. One group of patients received 5 mg/m<sup>2</sup> (max. 10 mg) of etanercept, another group received 12 mg/m<sup>2</sup> (max. 25 mg) of etanercept and a third group received a placebo. Vials of etanercept were reconstituted by aseptic injection of 1.0 mL Bacteriostatic Water for Injection, USP, (containing 0.9% benzyl alcohol). The  
30   reconstituted solution was not filtered during preparation or prior to administration. If storage was required, the reconstituted solutions were stored at 2-8°C (36-46°F) in the original vial or in a plastic syringe for a period of no longer than 28 days.

          Study drug was dispensed in syringes to patients to be self-administered at home. Study drug was given twice weekly at approximately the same time of day, and the site  
35   for injection rotated to a different site with each subcutaneous injection.

5 Patient Evaluations included:

Day 1 of Study Drug (prior to administration of drug)

Vital signs were taken for each patient, including blood pressure, heart rate and respiratory rate. In addition, each patient received a cardiopulmonary examination.

During study and at end of study (day 84)

10 Vital signs (blood pressure, heart rate, respiratory rate) were taken on days 28, 56 and 84; complete physical examinations and interim cardiac history were done on day 84; cardiopulmonary examinations were done on days 28, 56 and 84; 2-D echo/Doppler assessments were done on days 28 and 84. At the end of the study (day 84), the following tests were done: MUGA; CXR; ECG; CBC; differential; platelets; creatinine;  
15 SGOT/SGPT. In addition, AEs were recorded from patient diary (every visit). At days 28, 56 and 84, NYHA functional classification, 6 minute walk distance and Quality of Life questionnaires were done.

All subjects who received at least one dose of study drug were evaluated for safety (vital signs, physical exams, hematology profile, blood chemistry profile, hemodynamic  
20 parameters, urinalysis, antibody formation against TNFR:Fc, symptom/toxicity assessment).

Measurements of LV function

Clinical and laboratory indices of biological activity were assessed for evidence of improvement in left ventricular ejection fraction by MUGA, left ventricular volume by  
25 MUGA and left ventricular ejection fraction and dimension and cardiac output by 2-D echo.

Results

Doses of 5 and 12 mg/m<sup>2</sup> were well tolerated in CHF patients. Adverse events were consistent with this population and were equally distributed amongst the treatment  
30 groups, including the placebo group.

As illustrated in FIGURE 1, a shift to a lower NYHA classification was observed in patients who received either dose of etanercept, the shift being more pronounced in the group who received the higher dose. FIGURES 2A and 2B illustrate that, as compared with the placebo, the patients who received etanercept exhibited improved left ventricular  
35 ejection fraction by MUGA. Eight to thirteen percent of the etanercept recipients but none of the placebo group showed an at least 10% improvement in LV ejection fraction

5 (see FIGURE 2B). FIGURE 3 shows further that the patients who received etanercept exhibited an improved Quality of Life (MLWHF-physical dimension) as compared with the placebo group, and FIGURE 4 illustrates that a greater proportion of the etanercept recipients as compared with the placebo group ended the study with an improved clinical composite score. Furthermore, the benefits illustrated in FIGURES 2A, 2B, 3 and 4  
10 showed a dose-dependency that is consistent with the benefits being attributable to the etanercept.

As illustrated here, etanercept dosed for three months was well tolerated in patients with CHF and induced an overall improvement in their condition, as manifest by a number of indicators, including NYHA classification, clinical composite score,  
15 ventricular function and quality of life scores. These changes were more pronounced in the 12 mg/m<sup>2</sup> group, but were apparent also in the 5 mg/m<sup>2</sup> group.

#### Example 2. Multi-site randomized TNFR:Fc study in CHF patients

A double-blind, placebo controlled study will be conducted in multiple sites and  
20 will involve 900 patients with heart failure, stratified based upon baseline  $\beta$ -blocker use and NYHA functional class. This clinical trial will evaluate the efficacy of two dosing regimens of etanercept subcutaneous (SC) injections and placebo in patients with Class II-IV chronic heart failure (CHF). Endpoints will include the clinical composite score at 24 weeks and a combined analysis of all-cause mortality and morbidity (CHF  
25 hospitalizations). Specific covariates will be examined, including left ventricular ejection fraction (LVEF), etiology of heart failure, age, and gender. Baseline values for all study parameters will be determined by examining each patient within about 60 days prior to administration of the first dose of etanercept. Unless otherwise indicated, values for various indicators of heart disease (e.g., NYHA class, serum TNF $\alpha$ , walking test, left  
30 ventricle function, clinical composite score, MLWHF score, etc.) will be determined as described above in Example 1. The etanercept employed for this study and its preparation for injection is described above in Example 1.

The data obtained will be analyzed in combination with data from a second trial of etanercept whose design will be similar to this 900 patient clinical trial. A time to first  
35 event analysis will be included, and study duration will depend on event rate. The study will continue at least until all enrolled patients have completed 24 weeks of treatment, and

5 may continue for up to one year longer in order to observe the targeted number of events (389 events, including either mortality or CHF hospitalizations) for the combined patients in the two studies.

At 24 weeks, the following will be assessed and compared with baseline: changes in left ventricular ejection fraction; changes in global assessment of progress assessed by  
10 the investigator; and changes in Minnesota Living with Heart Failure (MLWHF) Scale, as based on the MLWHF Questionnaire. Additional measurements will include: characterization of the pharmacokinetics (and pharmacodynamics) of etanercept in a subset of patients with CHF; evaluation of the overall economic impact of the use of etanercept in patients with Class II-IV CHF by conducting a cost effectiveness analysis  
15 through the relative (compared with placebo) use of medical care; and safety analysis.

To be included in this study, patients must meet the following criteria: 18-85 years of age; agree to use contraception throughout the study; exhibit NYHA Functional Class II-IV CHF; have a ventricular ejection fraction  $\leq 30\%$ ; receiving stable ( $> 2$  weeks) therapy for heart failure; 6-minute walk distance  $> 50$  meters and  $< 375$  meters or  $< 425$   
20 meters plus hospitalization for CHF within previous 6 months. Patients included in the study must be receiving therapy for heart failure including a diuretic and an ACE inhibitor (unless there is a history of ACE intolerance or a contraindication to use), and may also be receiving digoxin, angiotensin II antagonist, beta blocker, amiodarone, nitrates, and hydralazine, but these medications must have been constant for 2 weeks prior to  
25 randomization. Female patients may not be pregnant or lactating. Throughout the study, treatment with antiarrhythmic drugs and nonsteroidal anti-inflammatory drugs will be avoided.

A detailed medical history will be taken prior to study entry, which will include ischemic heart disease; myocardial infarction; history of arrhythmia; hypertension; dilated  
30 cardiomyopathy; CHF history, including NYHA class; and history of recent hospitalizations. Patients during the study will be evaluated for vital signs and physical examination, cardiopulmonary assessment, routine labs, antibody formation against etanercept, and adverse events. Laboratory assessments will be performed at screening and at weeks 2, 4, 12 and 24.

35 To characterize the pharmacokinetics of etanercept, serum samples will be collected from a subgroup of 200 randomly selected patients at Day 1 and at the end of

5    Weeks 4, 12, and 24. Of the 200 patients, 40 patients from selected sites also will have  
serum for etanercept concentrations collected on Days 3, 5, 7, and 9. The concentration  
data will be combined with demographic and dose administration data. In addition,  
covariates potentially responsible for variability in pharmacokinetics will be examined,  
including weight, gender, ethnic background, age, and concomitant medication  
10    administration.

Dosing regimen. Starting on Day 1 of the double-blind period, three groups each  
containing 300 patients will receive by SC injection:

- 1) 25 mg of etanercept twice a week and placebo once a week;
- 2) 25 mg of etanercept three times a week; or
- 15    3) placebo three times a week.

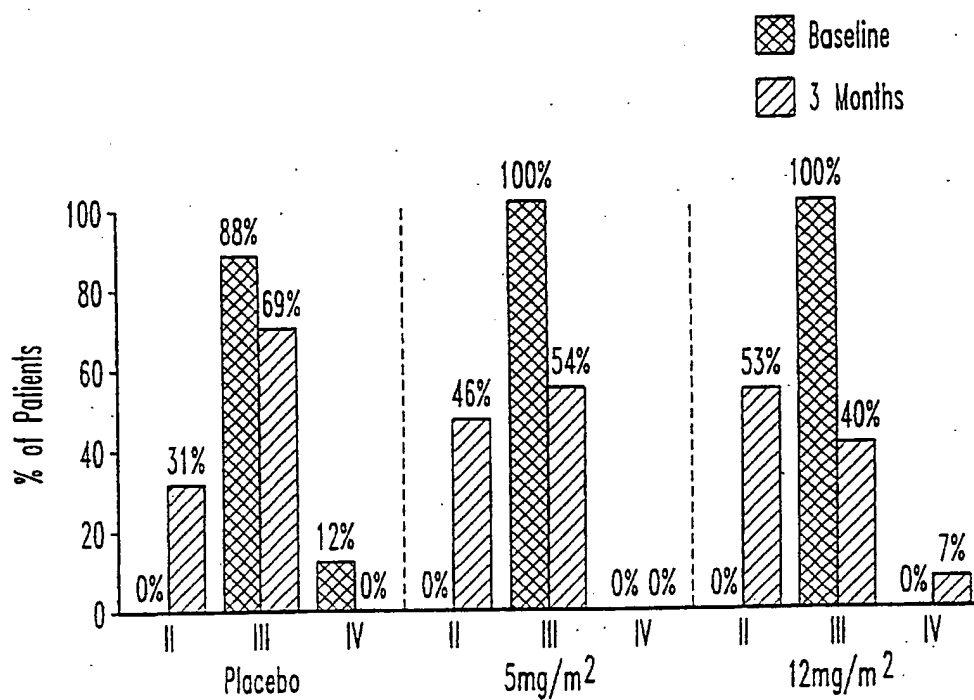
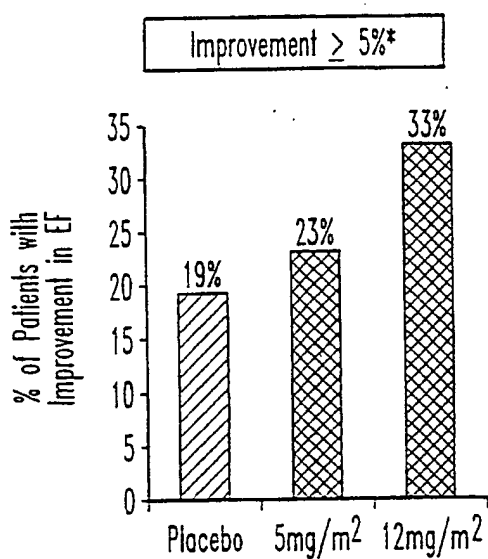
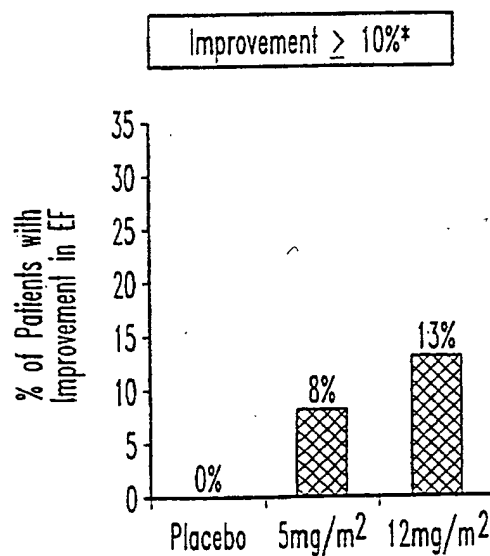
      Following completion of Week 24 of study drug or immediately after premature  
discontinuation (EOS), patient evaluations will include: NYHA classification; physician  
global assessments; changes in the Minnesota Living with Heart Failure (MLWHF) Scale  
and VAS; vitals signs including weight; limited physical exam; cardiopulmonary exam;  
20    review AEs and concomitant medications; routine laboratory; serum/plasma bank (for  
markers of heart failure); etanercept antibodies; chest x-ray; and change in left ventricular  
ejection fraction (MUGA) in 300 patients. After week 24, patients will continue to be  
evaluated every 12 weeks for physical condition, NYHA classification, laboratory tests,  
and anti-etanercept antibodies.



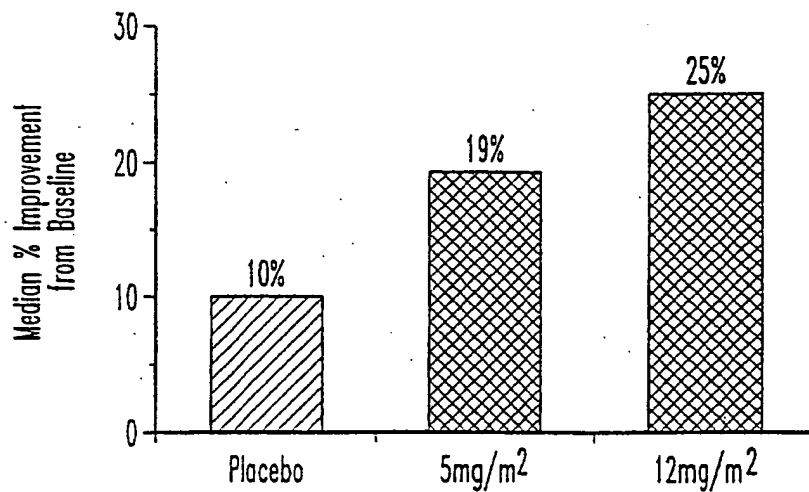
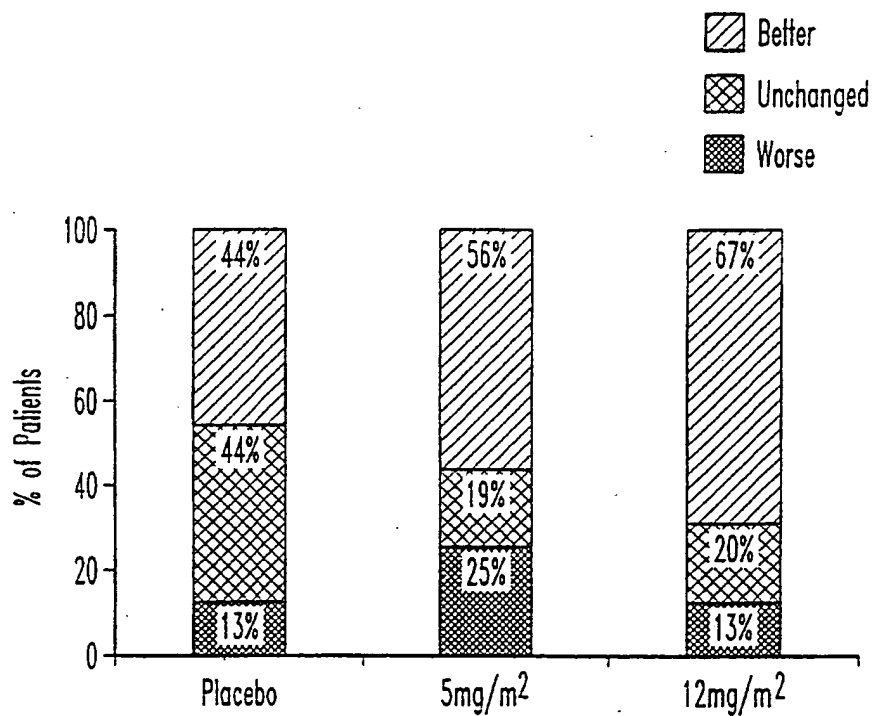
What is claimed is:

1. A method of treating chronic heart failure in a patient having chronic heart failure, said method comprising administering to the patient by subcutaneous injection a dose of TNFR:Fc at 5 mg/m<sup>2</sup> or 12 mg/m<sup>2</sup> per dose up to a maximum of 25 mg per dose at least two times per week for a time sufficient to induce a sustained improvement over baseline of an indicator selected from the group consisting of left ventricular ejection fraction, New York Heart Association class and clinical composite score, wherein the improvement is considered sustained if the patient exhibits the improvement on at least two occasions separated by at least four weeks.
2. A method according to Claim 1, wherein the sustained improvement is an at least 10% improvement over baseline in left ventricular ejection fraction.
3. A method according to Claim 1, wherein the sustained improvement is an improvement of at least one level in New York Heart Association class.
4. A method according to Claim 1, wherein the sustained improvement is an improvement in clinical composite score.
5. A method according to Claim 1, wherein the TNFR:Fc is administered three times per week.

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*Fig. 1**Fig. 2A**Fig. 2B*

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*Fig. 3**Fig. 4*

# INTERNATIONAL SEARCH REPORT

International Application No.  
PCT/US 00/08161

**A. CLASSIFICATION OF SUBJECT MATTER**  
IPC 7 A61K38/17 A61K38/19

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)  
IPC 7 A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, BIOSIS, MEDLINE

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DESWAL, A. ET AL: "A Phase I Trial Of Tumor Necrosis Factor Receptor (p75) Fusion Protein (TNFR:Fc) In Patients With Advanced Heart Failure" CIRCULATION, vol. 96, no. 8, 21 October 1997 (1997-10-21), page I-323 XP000925228 cited in the application abstract  — —/—	1

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

\* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "Z" document member of the same patent family

Date of the actual completion of the international search

24 July 2000

Date of mailing of the international search report

07/08/2000

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Authorized officer

Noë, V

# INTERNATIONAL SEARCH REPORT

Inter- national Application No  
PCT/US 00/08161

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	MORELAND L W ET AL: "Treatment of rheumatoid arthritis with a recombinant human tumor necrosis factor receptor (p75)-Fc fusion protein 'see comments!'" NEW ENGLAND JOURNAL OF MEDICINE, THE, US, MASSACHUSETTS MEDICAL SOCIETY, WALTHAM, MA, vol. 337, no. 3, 17 July 1997 (1997-07-17), pages 141-147, XP002115639 ISSN: 0028-4793 page 141, column 1, line 10 - line 15	1
A	BOZKURT, B. ET AL: "Pathophysiologically Relevant Concentrations of Tumor Necrosis Factor-alpha Promote Progressive Left Ventricular Dysfunction and Remodeling in Rats." CIRCULATION, vol. 97, no. 14, 14 April 1998 (1998-04-14), pages 1382-1391, XP000929170 cited in the application abstract page 1384, paragraph 4 page 1388, paragraph 2 -page 1389, paragraph 1	1
A	WO 97 30088 A (KENNEDY INST OF RHEUMATOLOGY) 21 August 1997 (1997-08-21) cited in the application page 31, line 21 - line 24 page 30, line 9 - line 29 page 29, line 23 page 28, line 2 - line 9	1
A	WO 94 06476 A (IMMUNEX CORP) 31 March 1994 (1994-03-31) page 16, line 30 - line 34; example 2 page 2, line 12 - line 13 abstract	1

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 00/08161

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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WO 9406476 A	31-03-1994	AU 670125 B AU 4920993 A CA 2123593 A EP 0620739 A JP 7504203 T NO 941780 A NZ 256293 A US 5605690 A	04-07-1996 12-04-1994 31-03-1994 26-10-1994 11-05-1995 15-07-1994 24-06-1997 25-02-1997